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Chen et al.

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(54) **IMPACT SCREWDRIVER**

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(71) Applicant: **CHERVON INTELLECTUAL
PROPERTY LIMITED**, Road Town
(VG)

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(72) Inventors: **Liang Chen**, Nanjing (CN); **Zhongxin
Xu**, Nanjing (CN)

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(73) Assignee: **CHERVON INTELLECTUAL
PROPERTY LIMITED (VG)**

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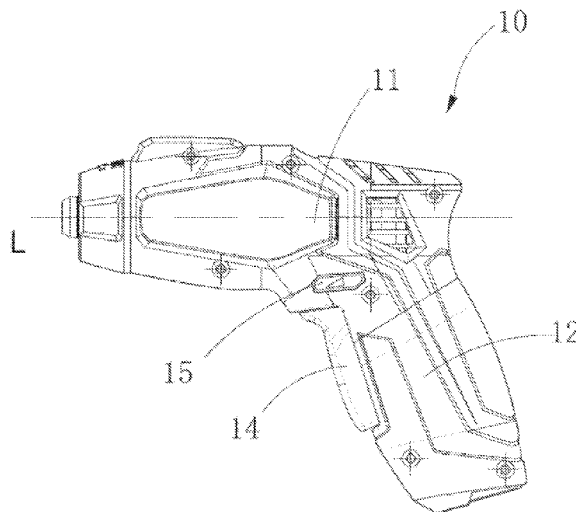
Assistant Examiner — Danny Hong

(74) *Attorney, Agent, or Firm* — Greenberg Traurig, LLP

(57) **ABSTRACT**

An impact screwdriver includes a housing, a battery arranged in the housing, an electric motor arranged inside the housing, a transmission part driven by the electric motor and an impacting part, the impacting part including a hammer, an anvil matched to and hammered by the hammer, and an output shaft revolved by the anvil, wherein the rated voltage of the battery is less than or equal to 4.25V, the impact frequency of the hammer and the anvil is at least 30 Hz, and the ratio of the output torque (Nm) of the output shaft to the rated voltage of the battery is 1.8~4.5.

9 Claims, 3 Drawing Sheets



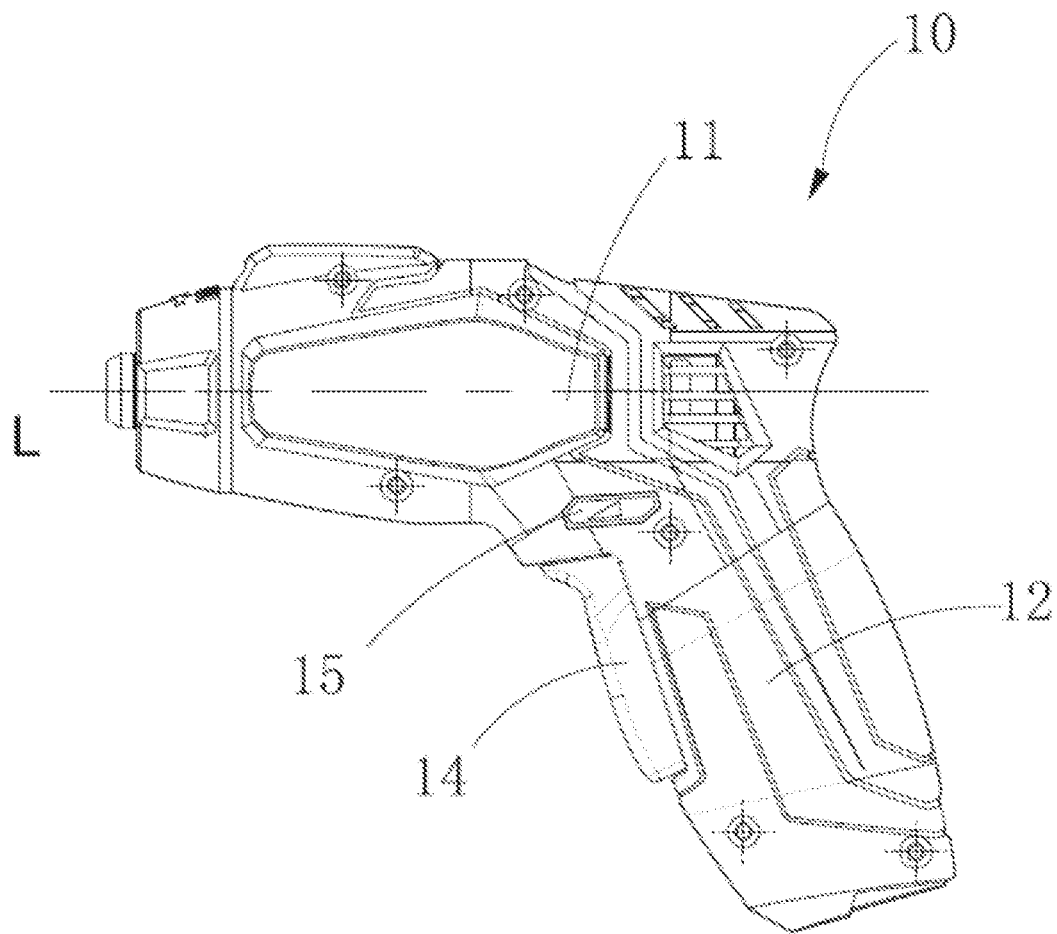


FIG.1

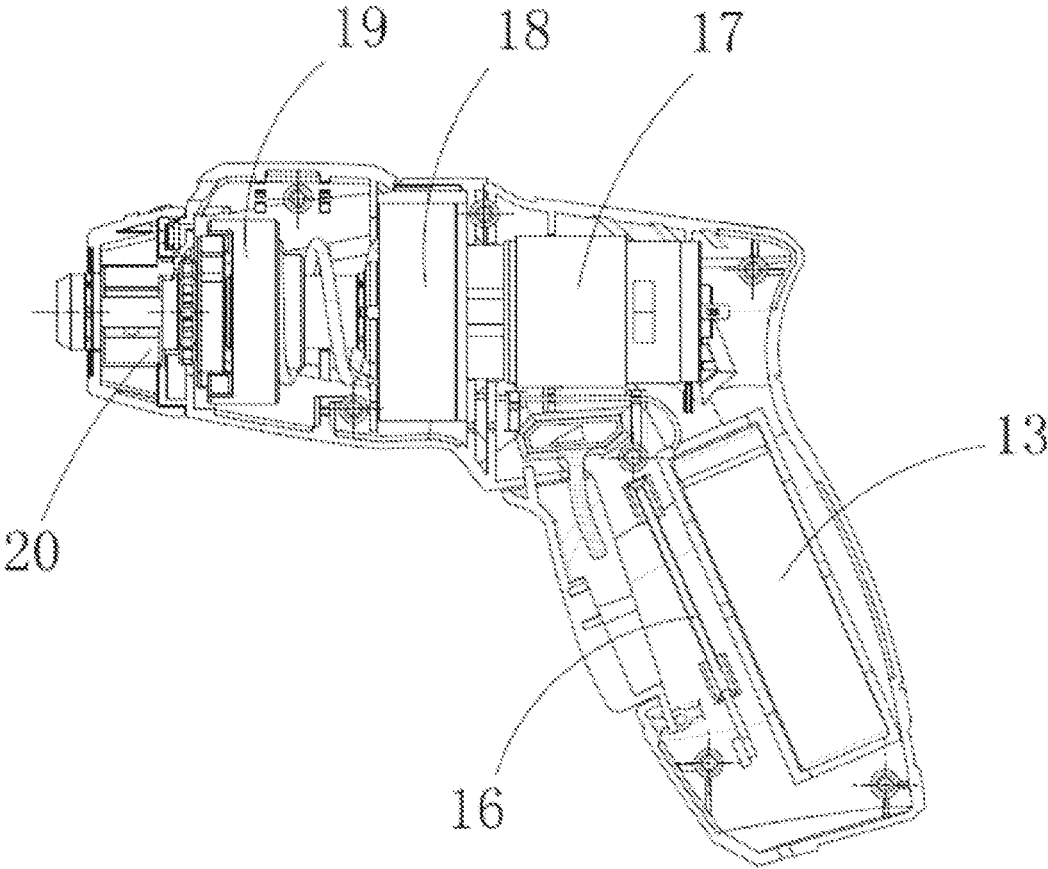


FIG.2

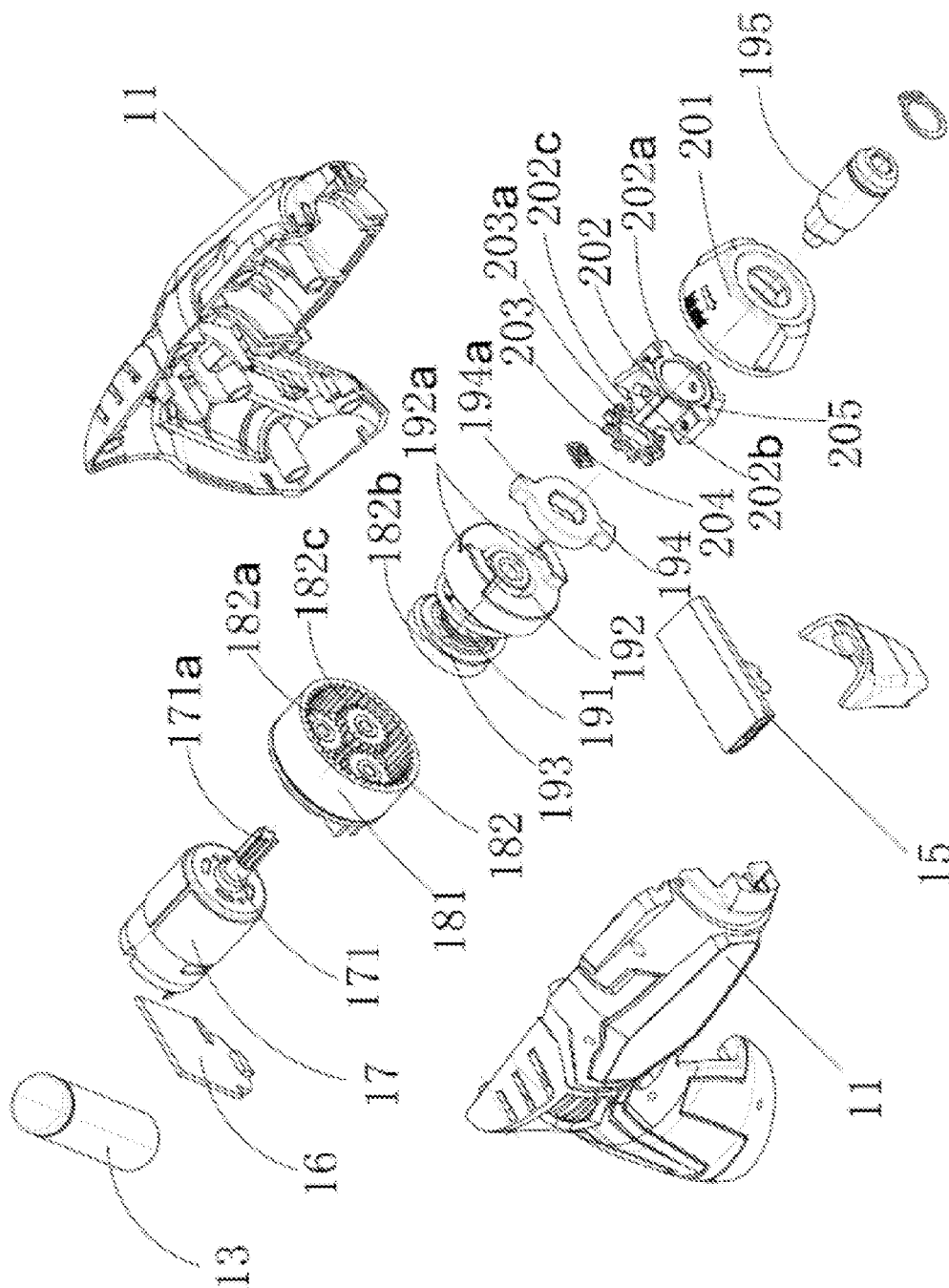


FIG.3

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IMPACT SCREWDRIVER**RELATED APPLICATION INFORMATION**

This application claims the benefit of CN 5
201310713648.9, filed on Dec. 20, 2013, the disclosure of
which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

The present disclosure generally relates to a hand-held
electric tool and, more particularly, to an impact screwdriver.

BACKGROUND

A screwdriver is a common household tool having the
advantages of being quick and portable, cheap and practical,
and widely usable. A common screwdriver usually cannot
screw completely or may cause slip with overexertion in the
process because of the constraints of output torque, which
brings unnecessary duplications of effort or in the steps of
switching manual tools to avoid slip and thus results in
tedious work and poor user experience.

In this case, an impact screwdriver with an additional
impact function is generally required, while tightening
screws, an output shaft of the impact screwdriver applies an
impact force on the screw with a predetermined frequency by
the driving of a motor, to improve work efficiency. However,
for DIY users, impact screwdrivers on the market are too
expensive to be popular. In addition, because tools are used in
different working conditions, common impact screwdrivers
cannot be fully competent in narrow space because of the
larger size, while small screwdrivers cannot meet demand
because of the low voltage output torque.

The statements in this section merely provide background
information related to the present disclosure and may not
constitute prior art.

SUMMARY

The object of the present disclosure is to provide a compact
impact screwdriver with low voltage and high output torque.

More particularly, the present disclosure describes an
impact screwdriver, including a housing, a battery arranged in
the housing, an electric motor arranged inside the housing, a
transmission part driven by the electric motor and an impact-
ing part, wherein the electric motor has a driving shaft to
provide a rotational output, and the transmission part decel-
erates the rotational output of the driving shaft and then
provides a rotational output, the impacting part comprising a
hammer, an anvil matched and hammered by the hammer, and
an output shaft revolved by the anvil, wherein the rated volt-
age of the battery is less than or equal to 4.25V, the impact
frequency of the hammer and the anvil is greater than 30 Hz,
and the ratio of the output torque (Nm) of the output shaft to
the rated voltage of the battery is 1.8~4.5.

Further, the output torque of the output shaft may be at least
8 Nm.

Further, the rated voltage of the battery may be 3.6V.

Further, the hammer, the anvil and the output shaft of the
impacting part may be powder metallurgical parts or preci-
sion castings, and the anvil and the output shaft may be
capable of being integrated or independent parts separately
formed.

Further, the impact screwdriver may also include a shaft
locking mechanism capable of switching the impact screw-
driver between an electric operation and a manual operation.

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Further, the shaft locking mechanism may include an oper-
ating element mounted on the housing that is operable
between a locked position and an unlocked position, a first
engaging element connected to the operating element, and a
second engaging element arranged on the output shaft,
wherein the first engaging element has a first position distal
from the second engaging element and a second position at
which the first engaging element is driven by the operating
element to move and engage the second engaging element.

Further, the outer surface of the first engaging element may
have a plurality of protrusions, a sliding slot may be provided
on the housing for the axial movement of the first engaging
element, and a plurality of grooves may be formed on the
outer circumferential surface of the second engaging element
to match with the protrusions.

Further, the operating element may be arranged to revolve
around the housing, the outer surface of the first engaging
element may have a chute in which a pin is arranged within
which the pin is capable of sliding by the revolving of the
operating element to force the axial movement of the first
engaging element.

Further, the shaft locking mechanism may also include a
shaft locking switch triggered by the operating element to
control the on-off operation of the motor circuit.

Further, the battery may be a lithium battery.

An impact screwdriver constructed according to the
present disclosure with fulfill the demands of low voltage and
high output torque as well as being portable and compact for
use in a narrow space.

Further areas of applicability will become apparent from
the description provided herein. It should be understood that
the description and specific examples are intended for pur-
poses of illustration only and are not intended to limit the
scope of the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front view of an exemplary impact screwdriver
constructed according to the present disclosure;

FIG. 2 is a cross-sectional view of the impact screwdriver
of FIG. 1; and

FIG. 3 is an exploded schematic view of the impact screw-
driver of FIG. 1.

The drawings described herein are for illustrative purposes
only of selected embodiments and not all possible implemen-
tations, and are not intended to limit the scope of the present
disclosure. Corresponding reference numerals indicate cor-
responding parts throughout the several views of the draw-
ings.

DETAILED DESCRIPTION

The following describes in detail an exemplary impact
screwdriver with reference to the attached figures. The fol-
lowing description is intended to be merely exemplary in
nature and is in no way intended to limit the claimed inven-
tion, its application, or uses.

By reference to FIGS. 1-3, an exemplary impact screw-
driver 10 is illustrated in the form of a tool having a shape that
is similar to a pistol, and includes a housing 11 which has a
substantially cylindrical part, a handle 12 arranged at an angle
to the cylindrical part, and a battery 13 arranged inside the
handle. The housing 3 has a longitudinal axis L along the
length direction of the cylindrical part, a switch 14 is arranged
on the handle 12 to control the machine to start, a reversing
button 15 is arranged on the adjoining part of the handle 12
and the cylindrical part, which is arranged on the both sides of

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the housing to control the machine to reverse, a PCB control panel 16 in front of the battery 13 is arranged inside the handle, a power display interface may be integrated on the PCB control panel 16, which has a visual display of the charge and discharge process of the tool, additionally, a charge and discharge protection device is arranged in the machine, which protects the charge and discharge process of the whole machine, to ensure the safe operation and working life thereof.

By reference to FIG. 2 and FIG. 3, one end of the housing 11 which is distal from the handle 12 is taken as the front, the other end as the rear, and an electric motor 17, a transmission part 18 driven by the motor 17 and an impact part 19 are arranged in turn along the longitudinal axis L from the front to the rear. The electric motor 17 has a driving shaft 171 providing revolving output and a motor gear 171a for transferring the power from the revolving output of the electric motor 17 to the transmission part 18 via the gear structure which is arranged on the top of the driving shaft 171. The transmission part 18 decelerates the revolving output of the driving shaft 171 to provide a revolving output. The transmission part 18 includes a gearbox 181 which accommodates a planetary gear decelerating system 182. According to the embodiment of the present disclosure, the planetary gear decelerating system is a single-reduction system which includes planetary gears 182a, a planetary carrier 182b and a ring gear 182c fixedly arranged in the gearbox 181. The planetary carrier 182b includes a cylindrical base and a plurality of planet pins evenly spaced on the base surface in the circumferential direction, the planet pins extend from the rear end of the base, a planetary gear 182a is arranged on each planet pin, and the driving shaft 171 of the electric motor 17 extends into the gearbox 181 to engage the planetary gears 182a accommodated inside.

A hole is arranged on the base of the planetary carrier 182b, fixedly connected to the intermediate shaft 191 of the impacting part 19 via an interference fit, thus the intermediate shaft 191 always revolves around the planetary carrier 182b. The impacting part 19 includes a hammer 192 arranged on the intermediate shaft 191, a spring 193 disposed between the hammer 192 and the planetary carrier 182b, and a V-shaped groove impact mechanism located on the adjoining part of the hammer 192 and the intermediate shaft 191, and, since the V-shaped groove impact mechanism noted above is a known mechanism for providing impact, the functionality provided thereby need not be described in further detail herein. A pair of first end gears 192a are arranged on the radial symmetric protrusion of the front surface of the hammer 192, an anvil 194 is arranged in the front end of the hammer 192, and a pair of second end gears 194a are arranged on the radial symmetric protrusion of the rear end surface of the anvil 194 opposite to the hammer 192. The impacting part 19 further includes an output shaft 195 extending beyond the front of the gearbox 181 and connected to the anvil 194. It is understandable that the anvil 194 and the output shaft 195 may be integrated or independent parts separately formed. A slot 1951 is arranged in the front of the output shaft 195, which can receive corresponding working heads while realizing different functions.

Next, the working principle of the impact screwdriver 10 in the embodiment of the present disclosure will be explained in details. The revolving of driving shaft 171 of the electric motor 17 results in a corresponding rotation of the motor gear 171a on the driving shaft 171. This action results in the planetary gear 182a rotating around the planet pin, while the planetary gear 182a crawls along the annular inner tooth of the ring gear 182c, and revolves around the axis of the driving shaft 171. The planetary carrier 182b is rotated by the revo-

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lution of the planetary gear 182a, and transfers the rotation to the intermediate shaft 191. The hammer 192 driven by the intermediate shaft 191 reciprocates in the axial direction via the V-shaped groove impact mechanism, and impacts the anvil 194 under the influence of the spring 193, and finally the impact force is transferred to the output shaft 195 through the anvil 194.

The impact screwdriver 10 further includes a shaft locking mechanism 20 being capable of switching the impact screwdriver 10 between the electrical operation and the manual operation, the shaft locking mechanism 20 includes an operating element 201 mounted on the housing 11, a first engaging element 202 coupled to the operating element 201, and a second engaging element 203 arranged on the output shaft 195, and a shaft locking switch 204. The shaft locking mechanism may be operated between a locked position and a unlocked position and, when the operating element 201 is in the unlocked position, the first engaging element 202 is in a first position distal from the second engaging element 203, the output shaft 195 is unlocked, and the shaft locking switch 204 is not triggered, the electric motor 17 can be opened, the machine can work properly, and when the operating element 201 is in the locked position, the first engaging element 202 is driven by the operating element 201 to move to a second position and engage with the second engaging element, the output shaft 195 is locked, the shaft locking switch 204 is triggered, and the electric motor 17 cannot be powered. By locking of the output shaft 195, the impact screwdriver 10 is switched from the electrical screwdriver operating mode to the manual screwdriver operating mode, and the circuit of the electric motor 17 is controlled to be disconnected upon being locked, thus the rotation of the electric motor 17 is cut off, and the safety performance of the machine is improved.

Particularly, the operating element 201 is rotatably arranged in the front end of the housing 11 and the body of the operating element 201 forms a cup-shape, which includes an opening for the output shaft 195 to pass through. The output shaft 195 is kept in an axial location through a clamping ring. The first engaging element 202 has a plurality of protrusions 202a on the outer surface, accordingly, the housing 11 has a plurality of sliding slots in the front, the first engaging element 202 is axially and movably arranged in the sliding slots along the output shaft 195 via the protrusions 202a, a chute 202b is arranged on the outer surface of the first engaging element 202, the operating element 201 is fixedly connected to a pin 205 that is slidably movable in the chute 202b, the pin 205 causes the axial movement of the first engaging element 202 by the revolving of the operating element 201. In other embodiments, the operating element 201 may be fixedly connected to the first engaging element 202 or integrated, an opening chute is arranged on the upper side of the housing 11, in which the operating element 201 is movable along the axial direction, and the first engaging element 202 moves due to the axial movement of the operating element 201. A plurality of grooves 203a is formed on the outer circumferential surface of the second engaging element 203 to match with the protrusions 202c extended from the rear end of first engaging element 202. When the first engaging element moves axially to the position where the protrusions 202a are engaged with the grooves 203a, the output shaft is locked. The shaft lock switch 204 close to the operating element 201 along the axial direction is arranged in the front of the housing 11, a convex surface is arranged on the operating element 201. When rotating to the lock position, the convex surface triggers the shaft lock switch 204 to cut off the circuit of the electric motor 17. It can be understood that, in the above implementation of the output shaft 195, the second engaging element 203 and the

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output shaft **195** are two independent elements formed separately, or form an engaging structure on the output shaft **195** directly, by which the first engaging element **201** locks the output shaft **195** directly. Additionally, the shaft lock switch **204** of the shaft locking mechanism **20** is triggered in a mechanical manner, or the lock state of the output shaft is monitored directly by the PCB control panel **16**, and can implement the on-off operation of the circuit in an electrical manner.

The ordinary screwdriver cannot be fully competent in the narrow space because of the larger size, while small screwdriver cannot meet user demands because of the low voltage output torque. In order to overcome the defects above, the battery's voltage and the performance parameters of the impact screwdriver need optimization, the battery used in the impact screwdriver **10** in the embodiment of the present disclosure is a built-in lithium battery. Because the voltage of a battery is usually proportional to the volume, the rated voltage of the battery is set to be less than or equal to 4.25v to reduce the volume, and a preferred range is between 3.6V to 4.2V. The rated voltage of the battery **13** used in the embodiment in the present disclosure is 3.6V, and forms an impact frequency greater than 30 Hz by the 20000 rpm of the electric motor, and a preferred impact frequency is between 35 Hz to 50 Hz; the output torque of the output shaft **195** is at least 8 Nm, and a preferred range is between 8 Nm to 16 Nm; the ratio of the output torque (Nm) of the output shaft **195** to the rated voltage of the battery is 1.8~4.5, and a preferred range is 1.8~4.3, and therefore the output with low voltage and the high output torque are realized.

The impact screwdriver **10** with the above parameters is smaller and more compact than an ordinary screwdriver, and it can be used in both ordinary scenes and narrow space, it is portable and can provide a higher output torque than an ordinary screwdriver, and it is equipped with the shaft locking mechanism **20** to switch between the electrical operation and the manual operation if necessary. Additionally, the elements of the impacting part, such as the hammer **192**, the anvil **194** and the output shaft **195**, utilize molded elements, for example, made of powder metallurgy materials or precision castings, which ensure strength while reducing the product's cost and make it more cost-effective.

The above illustrates and describes basic principles, main features and advantages of the present invention. Those skilled in the art should appreciate that the above embodiments do not limit the present invention in any form. Technical solutions obtained by equivalent substitution or equivalent variations all fall within the scope of the present invention.

What is claimed is:

1. An impact screwdriver comprising: a housing; a battery arranged in the housing; an electric motor arranged inside the housing; a transmission part driven by the electric motor,

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wherein the electric motor has a driving shaft to provide a first rotational output, and the transmission part decelerates the rotational output of the driving shaft and then provides a second rotational output; and an impacting part coupled to the transmission part comprising a hammer, an anvil matched to and hammered by the hammer, and an output shaft revolved by the anvil, wherein the rated voltage of the battery is 3.6V, the impact frequency of the hammer and the anvil is at least 30 Hz, and the ratio of the output torque (Nm) of the output shaft to the rated voltage of the battery is 1.8-4.5.

2. The impact screwdriver according to claim 1, wherein the output torque of the output shaft is at least 8 Nm.

3. The impact screwdriver according to claim 1, wherein the hammer, the anvil and the output shaft of the impacting part are at least one of powder metallurgical parts and precision castings, and the anvil and the output shaft are one of integrated or independent parts separately formed.

4. The impact screwdriver according to claim 1, wherein the impact screwdriver further comprises a shaft locking mechanism for switching the impact screwdriver between an electric operational mode and a manual operational mode.

5. The impact screwdriver according to claim 4, wherein the shaft locking mechanism comprises an operating element mounted on the housing that is operable between a locked position and an unlocked position, a first engaging element coupled to the operating element, and a second engaging element arranged on the output shaft; wherein the first engaging element has a first position distal from the second engaging element and a second position at which the first engaging element is driven by the operating element to move and engage the second engaging element.

6. The impact screwdriver according to claim 5, wherein the outer surface of the first engaging element has a plurality of protrusions, a sliding slot is provided on the housing for providing axial movement of the first engaging element, and a plurality of grooves are formed on the outer circumferential surface of the second engaging element to match with the protrusions.

7. The impact screwdriver according to claim 5, wherein the operating element revolves around the housing and the outer surface of the first engaging element is provided with a chute in which a pin is arranged for sliding movement by the revolving of the operating element to force the axial movement of the first engaging element.

8. The impact screwdriver according to claim 5, wherein the shaft locking mechanism further comprises a shaft locking switch triggered by the operating element to control an on-off operation of the motor circuit.

9. The impact screwdriver according to any one of claim 1, wherein the battery is a lithium battery.

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